UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
AGRICULTURAL SCIENCES

Vol. 3, No. 7, pp. 131-134 March 15, 1918

A NEW METHOD OF EXTRACTING THE SOIL SOLUTION

(*A Preliminary Communication*)

BY

CHAS. B. LIPMAN

While studying, in 1914, some of the data obtained by Quincke in measuring the forces by which thin water films are held by tiny particles of solid matter, there occurred to the writer a new possibility for a method of extracting the soil solution from soils with optimum moisture contents. By making a simple calculation, I found that if Quincke's figures were correct, particles of .005 mm. in diameter had the power of holding very thin films of water with a force equivalent to about 300,000 lbs. to the square inch. I argued, therefore, that since particles of .005 mm. diameter constitute the ''clay'' fraction in some mechanical analysis systems and since a large part of soil material may consist of much larger particles, that it should be possible to bring to bear on soils by pressure apparatus already in existence enough force to separate soil particles from some water, even when soils contained relatively small quantities of moisture. It appeared to me, moreover, that the large machines used in engineering laboratories for testing the strength of materials should be admirably adapted to the task of expressing water from soil if suitable containers for the soil are employed. With this idea as a basis, I started, in the year above mentioned, to experiment first on peat soils with a letter press of the old fashioned sort and found that water could be obtained with it from peat containing 40% of moisture. I then proceeded to have made a special perforated brass plate for the bottom of an iron casing about 12 inches long and about 6 inches in diameter. A quantity of clay adobe soil with optimum moisture content was placed in

the tube, a plate placed over it and pressure applied in a machine of a capacity of 200,000 lbs. to the square inch. About 25 c.c. of liquid were thus obtained from eight pounds of soil. The result of this experiment was unsatisfactory, owing to the small amount of liquid obtained from a soil with an optimum moisture content. I determined, therefore, to use a tube with a much smaller diameter (1 to 2 inches), so that the pressure exerted by the machine could be concentrated on as small a surface as possible and thus rendered more efficient. When such a tube was made, other difficulties were encountered. A few months later, these were surmounted and revised forms of apparatus were thus prepared from time to time as other duties permitted. No form of these was satisfactory even though I had demonstrated that small amounts of the soil solution could be obtained with some of them. During the last few months, however, I have had the privilege of the counsel of Mr. C. T. Wiskocil of the Department of Civil Engineering of this university, who has designed a new form of pressure tube for my purposes. Such a tube was made up and we have tried it out, recently, on several occasions with gratifying results. In the case of a very fine sandy soil containing an optimum moisture percentage (about 15% by weight), nearly two-thirds of the moisture was expressed from samples of 300 to 400 grams of moist soil. In the case of a clay loam soil, we were not so successful, but from two or three samples of about 300 grams each of such a soil containing about 20% of moisture (by weight), we obtained enough of the soil solution to make conductivity measurements and, if needed, quantitative analyses. Certain difficulties were encountered in pressing the clay loam soil, which did not obtain in the case of the fine sand, but these were also surmounted by another suggestion originating with Mr. Wiskocil. Even now we find that our apparatus needs to be changed, or a new one must be made to stand pressure in excess of 50,000 lbs. to the square inch, so that greater efficiency in pressing clay loams and clays may be attained. The detailed description of our apparatus, and of the results of conductivity measurements and analyses of the solutions obtained are reserved for description in another paper in which due credit will be given Mr. Wiskocil and Dr. D. D. Waynick for invaluable assistance rendered in connection with these matters.

My principal object now is to direct the attention of my colleagues in soil investigations to the fact that, after nearly four years of desultory effort, I have succeeded in demonstrating that direct pressure

can be used successfully for purposes of obtaining the soil solution as it exists in relatively thin films around the soil particles. The procedure is rapid, clean, and of high efficiency. With further improvements in apparatus which we are now planning, the method should supplant all other methods known today, including even the Morgan procedure.[1] None of the other methods are really satisfactory and even that of Morgan is laborious and slow, and introduces the factor of oil, which complicates and renders it extremely time-consuming and untidy. Within recent months, I have noted in the literature that attempts have been made by Ramann, März, and Bauer[2] and by Van Zyl[3] to use direct pressure as I have done. The original papers detailing the work of these investigations are not available to me, however, and I am almost entirely in the dark as to the details of the method and, in one case, of the magnitude of the pressures employed. The maximum pressure thus far exerted in my method has been approximately 53,000 lbs. to the square inch, whereas Ramann and his associates with a hydraulic press seem to have used only about 1500 lbs. per square inch. Moreover, if the abstract of their paper which is available to me has interpreted the authors correctly, their method is only applicable to soils made up of very fine particles or containing much organic matter. My experience has always been that the coarsest soils are always the easiest to manage in expressing water from them. Indeed, until recently, the fine grained soils, as above intimated, gave me considerable trouble, because they would creep out of the container in fine ribbons, while the pressure was being applied. Mr. Wiskocil's suggestion of a thin casing of sand for the fine grained loam or clay loam has obviated that difficulty, however. I judge from my experience, moreover, that Ramann and his coworkers must have used very wet soil or they could not possibly have secured solutions from them at the low pressure mentioned. The abstract of Van Zyl's paper says nothing about the pressure used by him and the manner in which it was applied. The statement is that the soil can be "squeezed." Other comparisons of my method with the comparable ones just discussed will be given in a later paper.

Finally, it may not be superfluous to emphasize the importance to all soil studies of the proper use of the method which I have described above. It allows of the direct determination of the concentration of

1 Soil Science, vol. 3, p. 531 (1917).

2 Int. Mitteil. Bodenkunde, vol. 6, p. 27 (1916), cited from Chem. Abst., vol. 11, no. 22, p. 3078 (1917).

3 Jour. Landw., vol. 64, p. 201 (1916), cited from E. S. R., vol. 36, p. 720.

the soil solution, and of the amounts of each of the solutes contained therein. It renders possible, further, such studies as will clarify our vision with regard to the relations, if any, which obtain between the soil solution and soil extracts as ordinarily made. It permits us for the first time, so far as I am aware, to obtain quickly and directly large portions of the soil solution as it exists naturally under field conditions when crops are growing, and thus to correlate these solutions in all their qualities with the conditions of the growing crop. It may doubtless be the means of throwing much light on the methods for making nutrient solutions for growing plants, and probably also on many obscure problems in plant physiological pathology. Indeed, the possibilities are many in which the method which I have described for obtaining the soil solution can be used to the very great advantage of soil and plant studies.

Transmitted March 8, 1918.